

Development of Novel Integrated Antennas for CubeSats

Novel Planar Antennas Developed for CubeSats

The Development of Novel Integrated Antennas for CubeSats project is directed at the development of novel antennas for CubeSats to replace the bulky and obtrusive antennas (e.g., whip antennas) that are typically used. The integrated antennas will not require mechanical deployment and thus will allow future CubeSats to avoid potential mechanical problems and therefore improve mission reliability. Furthermore, the integrated antennas will have improved functionality and performance, such as circular polarization for improved link performance, compared with the conventional antennas currently used on CubeSats.

These novel antennas are being developed using microstrip antenna technology that will be integrated directly onto the CubeSat frame, resulting in a low profile.

CubeSats are typically covered with solar panels, and it is important that they remain exposed to the light. A normal microstrip antenna placed on top of the solar panels will block the light. There are two approaches being used with microstrip antenna technology to overcome this problem:

- Transparent microstrip antennas
- Sub-solar microstrip antennas

In the first approach, the antennas are designed to be transparent (with transparency > 70%) so that the antennas can be placed on top of the solar panels. In the second approach, the antennas are placed below the solar panels and are designed to function well, even though covered by the solar panels.

The transparent approach has proven beneficial at higher frequencies, where the antennas are smaller and occupy less space above the solar panels. Designs have been fabricated at 2.45 GHz. Present designs have been linearly-polarized, but future designs will also be circularly-polarized. This will allow for improved communications



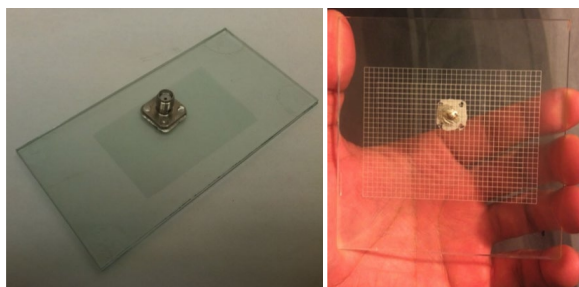
A 434 MHz antenna mounted onto a CubeSat frame, getting ready for testing. This sub-solar antenna looks like a solid block of copper, because that is how it was designed -- to fit the size of the CubeSat so that solar cells or other components can go on top of it without affecting the antenna performance. In essence, the antenna becomes part of the CubeSat frame.

regardless of the orientation of the CubeSat or the receive antenna at the Earth station. Circular polarization will also allow for future CubeSats to communicate more effectively with other satellites that use circular polarization, such as GPS and Iridium satellites. The present designs use a quartz substrate, which is transparent. In addition to the transparent quartz substrate, the microstrip patch and the antenna ground plane are also transparent, fabricated using a meshed metal surface or using a transparent metal film such as Indium Tin Oxide (ITO).

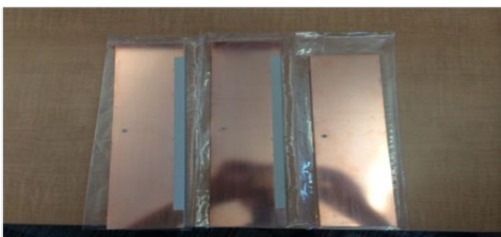
The sub-solar approach has proven beneficial at lower frequencies, such as 434 MHz. In this case, the antennas are not transparent and are placed below the solar panels. At lower frequencies microstrip antennas are larger, and this can be used to advantage. Through proper design, the antenna size can be tailored to cover the entire face of a CubeSat. The solar panels can then be placed on top of the antenna, just as they would normally be placed on the CubeSat frame. The antenna, in essence, actually becomes part of the CubeSat frame. The microstrip antenna radiates from its edges, which run

along the CubeSat edges, which are not blocked by the solar panels. Therefore, the antennas can still radiate well even though they are below the solar panels. Because the top of the microstrip antenna is metal, the solar panels do not disturb the antenna. Initial designs have been linearly polarized, but future work will also be directed at making circularly-polarized versions of these antennas.

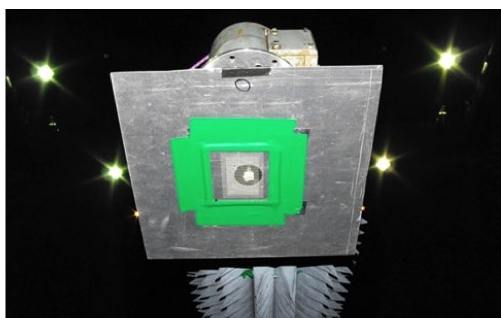
The development of integrated antennas will significantly increase mission reliability for CubeSats and other small spacecraft. Conventional antennas rely on a mechanical deployment mechanism, which is susceptible to breaking or jamming during deployment. The antenna is a critical



Transparent Microstrip Antennas for Use at 2.45 GHz. ITO Design (left). Mesh Design (right).



Sub-Solar Antennas after Fabrication, Designed for 434 MHz.



Transparent Antenna under Test at NASA Johnson Space Center.

element of the CubeSat, since all communication and navigation capabilities rely on it. Therefore, having integrated antennas will be a significant milestone in increasing mission reliability for CubeSats and other small spacecraft. The technology can also be used in other applications that will benefit NASA. This includes applications that require antennas that do not protrude from the surface of a structure for safety or other reasons, but which need to be transparent due to their location. It also includes antennas that require other components to be mounted on top of them to reuse space.

The work is being done at the University of Houston, in collaboration with NASA Johnson Space Center.

This project is funded through the SmallSat Technology Partnerships, a program within the Small Spacecraft Technology Program (SSTP). The SSTP is chartered to develop and mature technologies to enhance and expand the capabilities of small spacecraft with a particular focus on communications, propulsion, pointing, power, and autonomous operations. The SSTP is one of nine programs within NASA's Space Technology Mission Directorate.

For more information about the SSTP, visit:
<http://www.nasa.gov/smallsats>

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